



## Annual Report



# Enhancement of the Daily Raingauge Network in Mexico in Support of NAME



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### PROJECT DURATION

October 2003 - September 2006

### ANNUAL REPORT PERIOD

October 2003-September 2004

### NAME OF PRINCIPAL INVESTIGATOR

Dr. Wayne Higgins

### INSTITUTION

Climate Prediction Center, NCEP/NWS/NOAA

## 1.0 INTRODUCTION

This report summarizes progress on the installation of a simple raingauge network in NW México during the period October 2003 – September 2004. Activities were focused in two general areas: (i) implement an enhanced network of simple raingauges in Northwest and Northcentral Mexico and (ii) establish data collection procedures. Specific activities during FY 2004 included the raingauge purchase, shipping of the raingauges, network installation, data transmission and reporting, digitizing data, performing preliminary quality control and producing daily rainfall maps.

## 2.0 ACCOMPLISHMENTS

The following is a summary of accomplishments during the period October 2003 – September 2004.

### (i) Raingauge Purchase

In January 2004 NOAA/CPC purchased 1100 raingauges from Productive Alternatives Inc. (Fergus Falls, MN). This company was chosen after competitive bids from 4 vendors. Selection of the raingauge was based on (i) precision of the instrument (at least 1 mm); (ii) capacity of the raingauge (minimum of 150 mm); (iii) durability; (iv) readability; (v) ease of installation; (vi) ease of maintenance; (vii) availability of log sheets/books for recording data; and (viii) cost (including shipping). Total cost for the raingauge purchase was approximately \$16K plus ~\$2K for shipping / handling.

### (ii) Shipping of the Raingauges

The raingauges were shipped by truck from the manufacturer to the NAME Project Office (Boulder, CO) and then to Mexico through Nogales, Sonora. From there, the raingauges were sent to IMADES in Hermosillo, Sonora, and released to IMTA. The gauges were transported to CPA-SON for temporary storage (Fig. 1).



**Figure 1.** Storage facility at CPA-SON.

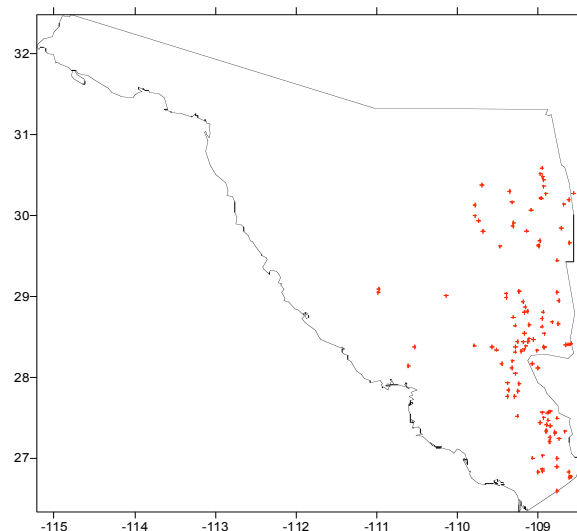
### (iii) Network Installation

Funds for IMTA activities were delayed until July 2004, which hampered efforts to install most of the network prior to the NAME 2004 EOP. Based on the late start, the IMTA team elected to install raingauges through the end of the 2004 rainy season (September 2004). As of this writing, 210 gauges have been installed, primarily in the State of Sonora. As explained later, the IMTA team will install the remaining gauges before the start of the 2005 monsoon in the states of Chihuahua, Sinaloa, Durango and Baja California.

Two short field trips were conducted during July-September 2004 for the installation of the raingauges. We used the facilities of CPA-SON in Hermosillo, Son., as headquarters and for raingauge storage. With the assistance of the Civil Protection Agency for the State of Sonora (CPA-SON), we were able to reach locations that were practically inaccessible due to the absence of paved roads. One of the specific objectives for this project was to install raingauges in remote areas away from other operating networks, mainly at high elevations in the SMO.

During the first field trip (July 24 to August 3) we installed 113 raingauges covering sites over the high elevations of the SMO. During the second field trip (August 24 to September 8) we installed 97 raingauges at lower elevations. The network (Fig. 2) is generally located in eastern Sonora in areas that are poorly sampled. The locations of the gauges are given in Table 1.

Pluviómetros instalados en el estado de Sonora para el proyecto NAME 2004



**Figure 2.** Location of the raingauges installed in the state of Sonora.

No.	Latitud	Longitud	Altitud (msnmm)	Nombre
1	29.6297222	-108.9891667	780	Sauz Nacori
2	29.4452778	-108.7616667	760	Tecoriname
3	29.6216667	-108.9922222	760	Buenavista
4	29.6627800	-108.6065800	2100	Arcos Lobos
5	30.5166667	-108.9675000	980	S.Miguelito
6	30.5900000	-108.9511111	960	Morita
7	30.4427778	-108.9261111	1000	Galerita
8	30.1366667	-108.6777778	1700	Agua Fria
9	30.1975000	-108.6177778	2100	Cienega Horcones
10	30.2769444	-108.5563889	2045	S.Jose Pozos
11	30.2688889	-108.9011111	1080	Tamichopa
12	30.0691667	-109.0855556	1460	Aribabi
13	30.2144444	-108.9644444	1100	Juribana
14	30.3002800	-109.3516700	680	S.Juan_Rio
15	29.9363900	-109.7355600	800	Jecori
16	28.7411111	-109.3055556	920	Guaycora
17	28.6397222	-109.2822222	1100	Encinal Bacanora
18	29.0313889	-109.3944444	400	Destacamento
19	28.8072222	-108.9361111	1180	Tarachi
20	28.7230556	-108.9513889	1340	Iglesia
21	28.6247222	-108.9491667	1380	T.Codorepe
22	28.6822222	-108.8263889	1600	Matarachi
23	29.0477778	-108.7591667	800	Natora
24	28.6577778	-108.7469444	1040	Mulatos
25	28.9472222	-108.7444444	700	Guadalupe Grande
26	28.4397200	-109.1230500	800	Guerigo
27	28.4666667	-109.0555556	1300	R.Trinidad
28	28.5413889	-109.1683333	940	Carrizal
29	28.5375000	-108.9244444	1440	Agua Blanca
30	28.3208333	-109.2027778	740	Concepcion
31	28.3119444	-109.2830556	480	Curea
32	28.3436111	-109.1736111	800	Guadalupe Toyopa
33	28.3719444	-109.2797222	500	Quema
34	28.3305556	-109.0094444	2000	Mesa Campanero
35	28.3819444	-109.1508333	900	Sta.Ana Yecora
36	28.4719444	-109.1058333	1100	Sta.Rosa
37	27.3011111	-108.7908333	1400	T.Moreno
38	27.4930556	-108.7630556	560	Burapaquito
39	26.8597222	-108.9458333	200	Paredones Alamos
40	26.8372222	-108.9430556	220	Rancho Viejo
41	26.8250000	-108.9972222	280	Piedras Blancas
42	26.8286111	-108.6180556	360	Mina de la Cruz
43	27.4388889	-108.9722222	440	S.Juan
44	27.4980556	-108.9269444	380	Cejaqui
45	27.3225000	-108.7905556	260	S.Rafael Sabino
46	26.5913889	-108.7605556	120	Sivilimora
47	26.9991667	-109.0652778	360	Tetajiosa
48	26.7616667	-108.6061111	240	Potrero Reuter
49	26.7702778	-108.5919444	200	Palos Chinos
50	26.8877778	-108.7650000	380	Laborcita
51	27.2361111	-108.7369444	520	Taymuco
52	26.9944444	-108.7625000	400	Plomosas
53	27.3288889	-108.6619444	1640	Llano
54	27.4094444	-108.8938889	180	Topiyeca
55	27.5638889	-108.9472222	300	Estrados
56	28.1127800	-109.0027800	1740	M.Colorada rosario
57	28.0436111	-109.2777778	460	Cuba
58	27.5597200	-108.8813900	260	Burapaco
59	28.1161111	-109.3252778	360	Nuri
60	28.1986111	-109.3180556	380	Palmarito
61	29.8419444	-108.7097222	1835	Mesa tres rios
62	29.6886111	-108.9794444	780	Nacori chico
63	29.8102778	-109.1383333	685	Bacadehuachi
64	30.4788889	-108.9397222	1000	Bavispe
65	30.3577778	-108.9288889	992	Bacerac
66	30.2130556	-108.9594444	1080	Huachinera
67	30.1652778	-109.3188889	622	Villa Hidalgo
68	29.8669444	-109.3105556	525	Granados
69	29.9055556	-109.3016667	510	Huasabas
70	29.6180556	-109.4697222	680	Divisaderos
71	29.8036111	-109.6802778	615	Moctezuma

72	30.3780556	-109.6927778	1095	Nacozari_Garcia
73	30.1277778	-109.7838889	806	Hoyos
74	29.9958333	-109.7802778	739	Cumpas
75	28.1644444	-109.0700000	1874	El_Filo
76	29.0063889	-110.1380556	563	Mazatan
77	28.9872222	-109.3936111	435	Bacanora
78	28.9300000	-109.1858333	465	Arivechi
79	28.8708333	-109.1586111	490	Bamori
80	29.0566667	-109.2341667	416	Sahuaripa_pje
81	29.0613889	-109.2336111	422	Sahuaripa_p_gob
82	28.8019444	-109.1666667	563	V.Tecupeto
83	28.8127778	-109.1327778	598	Cajon_Onapa
84	28.6458333	-109.1069440	680	Guisamopa
85	28.3763889	-108.9277778	1455	Yecora
86	28.3680556	-108.9169444	1483	J.D.Pimas
87	28.4191667	-108.5877778	1494	Dura_Yecora
88	28.4075000	-108.5944444	1445	kipur
89	28.4038889	-108.6272222	1562	Encinal_Yecora
90	28.3966667	-108.6605556	1493	Maycoba
91	28.3900000	-109.7888889	1240	Pilares
92	28.4347222	-109.1808333	670	S.Nicolas
93	28.4391667	-109.2558333	602	Tepoca
94	27.0283333	-108.9427778	443	Alamos
95	27.4666667	-108.8719444	225	Chorijoa
96	27.5758333	-108.8416667	325	Chinahuiro
97	27.5711111	-108.8641667	240	M.Colorada_alamos
98	27.3300000	-108.8969444	190	Esperanza_Norte
99	27.4000000	-108.8472222	233	CNDPI
100	27.2569444	-108.8550000	315	Yoricarichic
101	27.2013889	-108.8552778	365	Tescalama
102	27.7644444	-109.2902778	383	Cedros
103	27.8288889	-109.2447222	518	Estrella
104	27.9202778	-109.2330556	630	Paredones_Rosario
105	27.7611111	-109.3800000	475	Sta.Ana_Rosario
106	27.9255556	-109.3750000	483	Sauz_Rosario
107	28.3400000	-109.5144444	202	Rio_chico
108	28.1633333	-109.4480556	262	Movas
109	28.3766667	-109.5702778	198	Dura_Rosario
110	29.0905800	-110.9763300	220	Hillo_Telemax
111	29.0467200	-110.9783600	220	Hillo_Poncho
112	27.8411100	-109.3680600	440	Rosario
113	27.5211100	-109.2536100	200	Quiriego
114	28.1422222	-110.6052777	135	El_Triunfo
115	28.3750833	-110.5316667	267	La_Misa
116	28.2883889	-110.7130000	160	Ortiz
117	27.9492500	-110.0520000	2.5	San_Carlos
118	28.4601389	-109.5287778	250	Onavas
119	28.7646944	-109.6343889	256	Sosopa
120	28.8863333	-109.7477778	450	Rebeca
121	29.2902222	-109.7454167	401	San_Pedro
122	29.2133889	-109.7512500	400	San_Jose
123	29.1766389	-109.7536667	435	Nuevo_Tepepa
124	29.0598889	-110.0550278	670	Nacori_Grande
125	29.3721389	-110.4688056	370	San_Rafael
126	29.3831667	-110.4471389	370	Guadalupe
127	29.5424167	-110.1194167	501	Mazocahuia
128	29.5792500	-110.1334722	510	La_Aurora
129	29.6505278	-110.1322778	520	El_Malinote
130	29.7154167	-110.1651667	572	Baviacora
131	29.8252222	-110.2252500	570	Acanchi
132	29.7658056	-110.1924444	560	El_Rodeo
133	29.8634167	-110.2367222	600	San_Felipe
134	29.9110833	-110.2133889	630	Huespac
135	30.0070278	-110.2181111	670	Banamichi
136	30.1555278	-110.2438889	700	Sinoquipe
137	30.4376111	-110.0343056	901	Chinapa
138	30.6331667	-109.9695556	1009	Bacuahi
139	30.9921944	-110.2731389	1403	Cananea
140	30.3639722	-111.1005278	740	Estacion_Llano
141	30.1687222	-111.1211667	720	Benjamin_Hill

**Table 1.** Locations of the raingauges installed in summer 2004.

The positions of the raingauges were determined using a GPS instrument. Elevations were calculated using an altimeter, which based on previous experience is more accurate than the GPS. Detailed information on the observers at each site is also available and up to date.

We have many pictures showing the sites we visited and the training of the observers. On virtually all occasions we found the observers to be extremely receptive and glad to participate. As a general comment, many observers indicated that it would be useful to include max-min thermometers, and that they would gladly report the readings.

#### **(iv) Data Transmission and Reporting**

Through the support of Deputy Director, Ing. Carlos Jesús Arias, of CPA-SON, IMTA had access to Mexican Government facilities, and personnel. In addition, Ing. Arias provided access to the radio frequency band communication network of CPA-SON for rainfall data transmission, which greatly enhanced our capability to gather data (98% efficiency rate as of now) and to report it to the SMN. All data is also recorded on regular data sheets which are collected to fill in data gaps.

Data is reported over the radio only when the raingauge measures rainfall. This approach minimizes congestion on the radio waveband. An employee at the office of CPA-SON calls every site to receive rainfall reports on a daily basis. After the network interrogation is complete, the data are transmitted to IMTA, SMN and used at CPA-SON for operational purposes. Data are transmitted around 12 noon local time each day to SMN.

We are currently exploring other methods of data collection using an Internet database that would speed up the transmission of data to IMTA. IMTA and CPA-SON held several meetings on the conceptual design of this Internet-based automatic system. The system will be tested prior to the 2005 monsoon season.

There is a gap in the transmission of data during weekends. Nonetheless, we still have the data sheets and on Mondays the data from the previous two days is requested. In the future we will work with CPA-SON to provide a student or two, dedicated to data collection. This will be especially important as the size of the network grows.

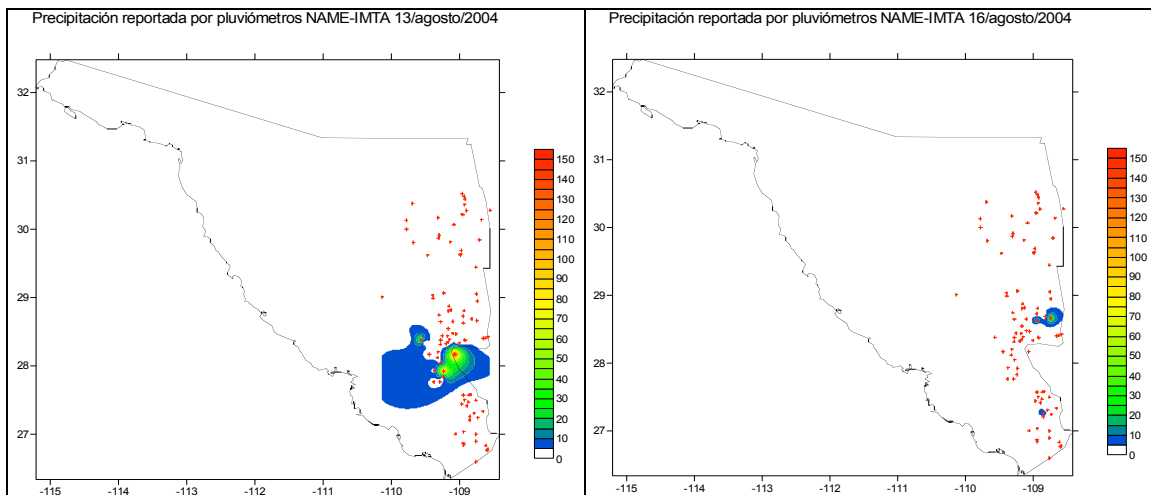
#### **(v) Digitize data, perform preliminary quality control and produce daily rainfall maps**

Roughly 95% of the data gathered so far has been digitized. The remaining data will be gathered by the IMTA team from the data cards provided by the observers.

Data collected during 2004 is formatted in MS Word, in which the name of the file is defined by the day, month and year. For example, rainfall reported on August 13<sup>th</sup>, 2004 has the file name 13082004.DOC

No.	Nombre	Precipit.
29	Agua_Blanca	Inap.
43	S.Juan	0.0
44	Cejaqui	0.0
45	S.Rafael_Sabino	0.0
46	Sivilimora	0.0
47	Tetajiosa	0.0
48	Potrero_Reuter	0.0
49	Palos_Chinos	0.0
50	Laborcita	0.0
54	Topiyeca	0.0
55	Estrados	0.0
56	M.Colorada_rosario	Inap.
64	Bavispe	0.0
67	Villa_Hidalgo	0.0
75	El_Filo	160
80	Sahuaripa_pje	0
94	Alamos	4.0
100	Yoricarichic	7.7
104	Paredones_Rosario	103
109	Dura_Rosario	29.3
110	Quiriego	0.0

Rainfall data is recorded from the day of installation of the raingauge. Maps of daily accumulated rainfall (Fig. 3) are available for the period August 13, 2004-present. This product is included in the Internet database and sent to the SMN. Daily maps are produced using a simple Cressman scheme with modifications.



**Figure 3.** Daily rainfall (mm) on August 13, 2004 (left) and August 16, 2004 (right) based on the simple raingauges installed in the State of Sonora.

### **III. FUTURE WORK**

During the period October 2004-September 2005 we will complete the following tasks:

#### **Task 1.2. Install simple raingauges in Northwest and Northcentral Mexico**

We will install an additional 959 gauges before the start of the 2005 monsoon season: 159 for Sonora, 350 for Chihuahua, 300 for Sinaloa and 150 for the Baja California. In Chihuahua we have a commitment from the Ranchers Association and CPA to help us reach our goal.

#### **Task 2.1 Collect data on a monthly basis**

Through the period we will continue to collect the data sheets and conduct preliminary quality control. Data will be provided to CPC and SMN for ingest in their respective climate data bases.

#### **Task 2.2 Digitize data and perform preliminary quality control**

The simple gauge data is being continually digitized by a team at IMTA. Quality Control (QC) (including buddy checks and maximum / minimum rainfall checks) is being thoroughly documented.

#### **Task 2.4 Develop a Web Accessible Database**

We will create a Web database to which all states will provide data in a uniform, easily accessible format. We will hire one or two part time students during the 2005 monsoon season to help collect the data. The web accessible database will be brought online during the 3<sup>rd</sup> quarter of FY05.

#### **Task 3.1 Incorporate the new data into CPC's historical daily Mexican precipitation data base**

After the preliminary quality control is completed at IMTA and the completeness of the reports is assessed, the data will be provided to CPC for ingest into the US\_Mexico Unified Raingauge Database (URD). CPC will begin incorporating the new Mexican gauge data into the URD during the 4<sup>th</sup> quarter of FY05.

#### **Task 3.2 Produce improved high resolution gridded daily analyses for Mexico**

High resolution gridded daily analyses for Mexico will be produced using CPC's Unified Raingauge Database (includes new Mexican gauge data via Task 3.1). The gridded analyses will



be made available to the broader science community. The new analyses will be compared to previous analyses generated by CPC to assess the influence of the new data.

#### **IV. EXPECTED OUTCOME**

It is anticipated that the network will continue to be operated by the SMN after the end of the proposal cycle as part of the NAME legacy program. It is expected that data from the operating network will be available for future research studies and for operational activities. There is the potential to expand this activity to a near real time climatological network using low cost equipment (e.g. the simple raingauges and max-min thermometers) and radio data transmission.

Aside from helping NAME achieve its objectives, this activity has the potential to be important for many other applications, including hazards assessments (e.g. fire risk assessment, flash floods) and for public health, agriculture, etc. Participants have been universally willing to help and are interested in expanding coverage of the network. Even in remote areas, where we met with several ethnic groups (some of whom do not speak Spanish), we found strong interest.

#### **V. PUBLICATIONS AND PRESENTATIONS:**

##### ***Conference Presentations / Preprints:***

Lobato, R., 2003: IMTA Participation in NAME. 5<sup>th</sup> Meeting of the NAME SWG, Puerto Vallarta, MX Nov 6-7

Lobato, R. 2003: The NAME Simple Raingauge Network and IMTA Participation in NAME. 6<sup>th</sup> Meeting of the NAME SWG, Tucson, AZ, 21-23 April, 04

##### ***Meetings Attended:***

Seattle Winter Season Weather Workshop briefings (Oct. 03)  
28<sup>th</sup> Climate Diagnostics and Prediction Workshop (Reno, NV; Oct. 03)  
NCEP Seminar: NAME: Status and Plans (Oct. 3, 2003)  
NAME Special Session (UGM) (Puerto Vallarta, MX; Nov. 03)  
NAME SWG-5 (Puerto Vallarta, MX; Nov. 03)  
CLIVAR Pacific and Atlantic Proposal Panel (Silver Spring, MD; Nov. 03)  
NWS HQ Briefing on NAME Soundings (Washington DC; Dec 03)  
NAME EOP/IOP Planning Meeting (Boulder, Co, Mar 04)  
7th WCRP CLIVAR/VAMOS Panel Meeting (Guayaquil, Ecuador; Mar 04)  
NAME Operations Review / Forecaster Orientation / 6th NAME SWG Meetings (Tucson AZ; Apr. 04)  
COMET Course (North American Monsoon) (Boulder, CO, Apr. 04)  
International CLIVAR Conference (Baltimore, MD, Jun. 04)

Pan American Panel Meeting (Baltimore, MD, Jun. 04)  
CLIVAR SSG Meeting (Baltimore, MD, Jun. 04)  
NAME Forecast Operations Center (Tucson, AZ, Jul 04)  
NAME Forecast Operations Center (Tucson, AZ, Aug. 04)  
GAPP PI Meeting (Boulder, CO, Aug 04)  
GAPP SAG Meeting (Boulder, CO, Aug 04)  
29<sup>th</sup> CDPW (Madison, WI, Oct 04)

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